

RELATIONSHIP BETWEEN CARBON DIOXIDE LEVELS AND REPORTED CONGESTION AND HEADACHES ON THE INTERNATIONAL SPACE STATION

INTRODUCTION: Congestion is commonly reported during spaceflight, and most crewmembers have reported using medications for congestion during International Space Station (ISS) missions. Although congestion has been attributed to fluid shifts during spaceflight, fluid status reaches equilibrium during the first week after launch while congestion continues to be reported throughout long duration missions. Congestion complaints have anecdotally been reported in relation to ISS CO₂ levels; this evaluation was undertaken to determine whether or not an association exists.

METHODS: Reported headaches, congestion symptoms, and CO₂ levels were obtained for ISS expeditions 2-31, and time-weighted means and single-point maxima were determined for 24-hour (24hr) and 7-day (7d) periods prior to each weekly private medical conference. Multiple imputation addressed missing data, and logistic regression modeled the relationship between probability of reported event of congestion or headache and CO₂ levels, adjusted for possible confounding covariates. The first seven days of spaceflight were not included to control for fluid shifts. Data were evaluated to determine the concentration of CO₂ required to maintain the risk of congestion below 1% to allow for direct comparison with a previously published evaluation of CO₂ concentrations and headache.

RESULTS: This study confirmed a previously identified significant association between CO₂ and headache and also found a significant association between CO₂ and congestion. For each 1-mm Hg increase in CO₂, the odds of a crew member reporting congestion doubled. The average 7-day CO₂ would need to be maintained below 1.5 mmHg to keep the risk of congestion below 1%. The predicted probability curves of ISS headache and congestion curves appear parallel when plotted against ppCO₂ levels with congestion occurring at approximately 1mmHg lower than a headache would be reported.

DISCUSSION: While the cause of congestion is multifactorial, this study showed congestion is associated with CO₂ levels on ISS. Data from additional expeditions could be incorporated to further assess this finding. CO₂ levels are also associated with reports of headaches on ISS. While it may be expected for astronauts with congestion to also complain of headaches, these two symptoms are commonly mutually exclusive. Furthermore, it is unknown if a temporal CO₂ relationship exists between congestion and headache on ISS. CO₂ levels were time-weighted for 24hr and 7d, and thus the time course of congestion leading to headache was not assessed; however, congestion could be an early CO₂-related symptom when compared to headache. Future studies evaluating the association of CO₂-related congestion leading to headache would be difficult due to the relatively stable daily CO₂ levels on ISS currently, but a systematic study could be implemented on-orbit if desired.